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AUTHOR von Glasersfeld, Ernst
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ABSTRACT

A constructivist analysis of the concepts of communication and environment may go against the traditional ideas of realists. Both concepts are treated as subjective constructs of a cognizing agent. It is held that the basis of the constructivist theory of knowing as the idea that knowledge is a mapping of ways of acting and thinking and the result of an individual's own cognitive activity, and not a commodity residing outside the knower that can be conveyed by linguistic communication. This paper considers the concept of environment and the concept of communication from the epistemological view of constructivist philosophy as key concepts in a theory of knowing. (CW)

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ENVIRONMENT AND COMMUNICATION

Ernst von Glasersfeld
Behavioral Research Institute, U. of Georgia &
Cognitive Processes Research Group, U. of Massachusetts

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Preliminary Remarks

In this paper I am to lay out some of the epistemological considerations, concerning the concepts of ***environment*** and ***communication***, that arise from the radical constructivist approach to the problems of knowing. Radical Constructivism is, indeed, a *theory of knowing*, and it is "radical" because it differs radically from traditional *theories of knowledge*. It would seem appropriate, therefore, to preface the discussion of the two key concepts with a few preliminary remarks about constructivism, a term that has recently become quite fashionable and, consequently, is frequently being used in ways that do not seem compatible with the approach I intend to expound here.

Good teachers and perceptive cognitive psychologists have always been aware of the fact that what we call *knowledge* does not enter the uninitiated head in large, complex wholes but must be built up from components which, all too often, have to be very small, elementary pieces. In Plato's Theaetetus, Socrates gives an exemplary demonstration of how such a build-up can be guided by an experienced practitioner. Thus, there is nothing new about the notion that students (or other cognitively developing organisms) have to *construct* such knowledge as they can by some form of reflection upon experiences provided by a teacher's discourse, a text book, or their own living.

In his Latin treatise on epistemology of 1710, the Neapolitan philosopher Giambattista Vico[1] formulated this notion of cognitive construction as explicitly as one might wish; and others--among them Kant[2], Vaihinger[3], Simmel[4], Baldwin[5], and Piaget[6]--have taken cognitive construction for

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granted. If academic psychologists and educational researchers have now come round to adopting this notion and call themselves "constructivists", it may be a sign of individual enlightenment, but, as far as their awareness of the epistmological underpinnings is concerned, it may also be misleading. Actually, Vico went a large step further in his theory of knowledge: he deliberately and explicitly renounced the traditional contention that knowledge *should* reflect the world in an "objective" ontological way and he declared that human reason could (and should) contemplate and govern the world of human experience and not the world as God might have made it. What I have called "Radical Constructivism" then builds on Vico's insight and adds the perspective that instrumentalists ever since Mersenne' have taken, namely that knowledge cannot aim at "truth" in the traditional sense but concerns the construction of paths of action and thinking that an unfathomable "reality" leaves open for us to tread. The test of knowledge, therefore, is not whether or not it accurately *matches* the world as it might be "in itself"--a match which, as the sceptics have reiterated, we could never check out-- but whether or not it *fits* the pursuit of our goals, which are always goals within the confines of our own experiential world.

From the perspective of radical constructivism, the common sense notion of *environment*, which underlies most scientific thinking, is untenable. This common sense notion arises quite naturally when the child coordinates experiences from different sensory modalities and, insofar as these coordinated experiences turn out to be repeatable, "externalizes" them in the form of more or less permanent obects. Piaget has called this a "Copernican revolution" which culminates with the child beginning to think of itself as "a thing among other things" in a stable universe. As the child continues and enriches the construction, this external world, then, becomes much more plausible and solid when the use of language seems to corroborate many of the sensory experiences the individual has externalized. Indeed, the ob-

jective "reality" of the sensory objects one has talked about with other experiencing subjects becomes so strong a conviction that it can lead philosophers to speak of "referents" as though these items existed independently in the "outside world" before an individual experience of them had been associated with the appropriate word. Hence, the concepts of environment and communication are intimately interconnected. However, because the externalization that generates the sphere of experience that we ordinarily call "environment" must have begun and proceeded to a certain level of complexity before anything like communication can take place, I shall discuss the two notions in that order.

The Concept of Environment

The French poet Henri Michaux once remarked that when he woke up in the morning he felt like an amoeba groping to establish its own boundaries. This is a powerful metaphorical description of what every cognizing subject must go through before it can come to consider itself as a discrete body among other physical items in a more or less permanent world. As I suggested above, it is a ***conceptual*** process because, on the one hand, it depends on creating associations between sensory experiences (rather than on the individual experiences themselves) and, on the other, more importantly, it depends on the ability to perceive the repetition of experiences.

From a realist point of view, repetition seems to be no problem. If things are *there*, prior and independent of the perceiver, all one has to do to repeat, say, a visual experience, is look at something twice. In fact, realists are usually quick to flip the problem around and to declare that ***because*** we can have the same experience more than once, it is clear that the thing we experience must ***be*** there.

From the constructivist point of view, however, the first question is *how do we come to know that an experience we are having now is the same that we had a moment ago?* Looked at closely, there are hardly ever two experiences such that we

could not find a difference between them. Yet, to giva an example, in spite of the fact that the sun has set and my visual experience of the glass of wine in front me has a different color now,compared to a moment ago, and in spite of the fact that, because I have emptied the glass and moved it closer to the bottle, it looks smaller now and has no wine in it, I have no qualms in considering it the *identical* glass that I saw a moment ago. In other words, there are always differences that I consciously or unconsciously *disregard* in order to establish the permanence of an individual identity. This disregarding differences is an essential component of the process of ***assimilation***, the process that enables us to externalize experiential items.

The aspect most important to the present discussion is that assimilation is an activity on our part, an activity that ***we*** have to carry out in order to establish an externalized object's individual identity and permanence. We may carry it out habitually or even "instinctively", but there is no external or logical necessity to do so. Rather, it is part of our conceptual construction of the experiential environment, and all we can infer from it about the "real" world is that it allows us successfully to assimilate a variety of objects sufficiently often so that it becomes useful to act as though they belonged to an objective external environment. And if something works for us with a certain reliability, we tend to think that we have discovered the workings of the *real* world.

The impression of an object's independent ***objective existence*** is greatly enhanced, once we have peopled our experiential field with "others", i.e. organisms to whom we attribute much the same properties and capabilities we believe to possess ourselves. Take for example a perfectly ordinary situation. A child approaches a hot stove, reaches out, and then recoils in a way that we, who happen to observe it, interpret as indicating pain. Almost inevitably we will feel confirmed in the belief that the stove is actually there and that it is hot in an ***objective*** sense. The child,

we might say, is gaining knowledge of the environment--once burned, twice shy.

What we totally disregard whenever we make such inferences, is that the stove and everything else that we consider to be around the child, is not an *objective* environment but merely that part of our own perceptual field that we have separated from the child on whom we are focusing our attention at the moment. We conceive of the child *in* that environment in the same way as we consider, say, the drawing of a flower the ***figure*** that interests us while we disregard as ***ground*** the sheet of paper on which it has been drawn. In that second case, it is quite clear that both the figure and its ground are parts of our own experience. In the case of the child getting burned, however, we disregard that everything we observe is under all circumstances part of our experience and, disregarding that it is we who have externalized it, we tend to think that what we have categorized as the child's environment has an existence that is independent of us because the child reacts to it in a way that we consider similar to the way we ourselves would react.

This does not mean that to a radical constructivist it makes no sense to speak of environment. But from the constructivist perspective organism/environment, figure/ground, subject/object, and a host of other dichotomies of the kind are categorizations that a cognizing agent imposes on his or her experience and neither of the two mutually dependent terms can ever be less "subjective" than the other. The contemporary foundation of the theory of subjective environments was laid over fifty years ago by the biologist Jakob von Uexküll, who showed that what an organism experiences as environment necessarily depends on the organism's ways and means of perceiving and acting.*

For educational research and for education, this way of thinking has certain consequences. In both disciplines one constructs general as well as particular models of students. While realists tend to think that their models should, and to some extent do, reflect the students as they *really* are,

constructivists must remain aware of the fact that models cannot reflect anything but the model builder's own conceptual constructs that he or she has externalized and kept constant by a continual process of assimilation and accommodation. Opponents of radical constructivism are prone to interpret such statements as manifestations of solipsism, as though the constructivist approach denied a world beyond one's experiential coordinations and categorizations. In doing so, they misinterpret the role of accommodation. The constructivist is fully aware of the fact that an organism's conceptual constructing is not fancy-free. On the contrary, it is constantly curbed and held in check by the constraints it runs into. The crucial point, however, is that, from this perspective, accommodation (i.e. a change of the model) takes place, not because a conceptual structure or model has proven ***false***, but because it no longer serves the chosen goal. Conversely, a conceptual structure or model cannot be considered ***true*** in an ontological sense, when it continues to work satisfactorily--it can only be said to have so far maintained its viability.

The task of education, then, can no longer be seen as a task of conveying ready-made pieces of knowledge to students, nor, in mathematics education, of opening their eyes to an absolute mathematical reality that pervades the objective environment like a crystalline structure independent of any mathematician's mental operations. Instead, it becomes a task of inferring first of all models of the students' conceptual constructs and then generating hypotheses as to how the students could be given the opportunity to modify their structures so that they lead to mathematical actions that might be considered compatible with the instructor's expectations and goals.

It is in this sense that the term "environment" gains importance in the constructivist approach. It is an environment that the teacher creates by setting up what he or she considers constraints that are likely to lead the student to propitious accommodations. It ought never to be, as it un-

fortunately often is, an environment based on the assumption that what is obvious to the mathematical initiate will be obvious to the novice as well.

The Concept of Communication

In its early stages, the technical theory of communication[10] has developed a diagrammatic schema that explicitly mapped the process as it appears to an outside observer. Consequently, success or failure of a communication event was determined on the basis of the observable behavior of a sender and a receiver. This schema was highly successful in the work of communication engineers. As it happens, it was also immediately applicable to the behaviorist approach to teaching and learning. There, the teacher's task was reduced to providing a set of stimuli and reinforcements that were intended to condition the student to "emit" behavioral responses considered appropriate by the teacher. In the case of subject matter that has to be learned by heart, the model and the method based on it have worked very well. Since there is no room in the behaviorist approach for what is ordinarily called ***understanding***, it is not surprising that this method rarely produces it.

In contrast, the constructivist approach to education is predominantly interested in the students conceptual structures and operations, and focuses on behavioral manifestations only insofar as they serve the teacher or experimenter to infer the student's understanding. Consequently, the original model of communication must be considerably expanded in the area of the sender and, more important still, in the area of the receiver.

One of the revolutionary aspects of Claude Shannon's work on communication[11] was that it established incontrovertibly that the physical *signals* that pass between communicators--for instance the sounds of speech or the visual patterns of print or writing in linguistic communication--do not carry what is ordinarily considered "meaning". Instead, they carry ***instructions to select*** particular meanings from a list,

which, together with the list of convened signals, constitutes the communication code. If the two lists of the code are not available to a receiver before the linguistic interaction takes place, the signals are meaningless for that receiver.

To give a simple example, if you ask at the "Information" counter at an airport at what time the plane from Boston is scheduled to arrive, and you get the answer "2:45 PM", the string of acoustic signals that constitutes that utterance could have no meaning for you ***unless*** you already have the coceptual schema in your head (as part of the present-day English code) *that divides the day into twice twelve hours and each hour into sixty minutes.* If, however, as a competent speaker of English, you are aware of that schema, the received signals enable you to ***select*** one particular point of the 1440 possible points that the conventional temporal schema contains.

If it is the case that such conceptual schemas--and indeed concepts in general--cannot initially be ***conveyed*** or transported from one to the other by words of the language, this raises the question of how language users acquire them. The only viable answer seems to be that they must abstract them from their own experience. The process of language acquisition in children, in fact, illustrates this very well. Though it is often said that normal children acquire their language without noticeable effort, a closer examination shows that the process involved is not as simple as it seems. If you want your infant to learn the word "cup", you will go through a routine that parents have used from time immemorial. You will point to, and then probably pick up and move an object that satisfies your definition of "cup", and at the same time you will repeatedly utter the word. It is likely that mothers and fathers do this "intuitively", i.e., without a well-formulated theoretical basis. They do it because it usually works. The reason why it works is not too difficult to find. There are at least three essential steps the child has to make. The first consists in focusing at-

tention on some specific sensory signals in the manifold of sensory signals which, at every moment, are available; and the parent's pointing provides an approximate and usually quite ambiguous direction for this act. The second step consists in isolating and coordinating a group of these sensory signals to form a more or less unitary item or "thing". The parent's moving the cup greatly aids this process because it accentuates the relevant figure as opposed to the parts of the visual field that is to form the ground. The third step, then, is to associate the isolated visual pattern with the auditory experience produced by the parent's utterances of the word "cup". Again, the child must first isolate the sensory signals that constitute this auditory experience from the background consisting of the manifold auditory signals that are available at the moment, and the parent's repetition of the word obviously enhances the process of isolating the auditory pattern as well as its association with the unitary visual item.

If this sequence of steps provides an adequate analysis of the initial acquisition of the meaning of the word "cup", it is clear that the ***child's*** meaning of that word is made up exclusively of elements which the child abstracts from her own experience. Indeed, anyone who has methodically watched children acquire the use of new words, will have noticed that what they isolate as meanings from their experience is often only partially compatible with the meanings the adult speakers of the language take for granted. Thus the child's ***concept*** of cup often for quite some time includes the activity of drinking (and sometimes even the specific activity of drinking milk) before the continual linguistic and social interaction with other speakers of the language provides occasions for the accommodations that are necessary to adapt the child's concept of cup to the uses of the word in contexts as divergent as the hubs of automobiles and the races of yachts. In fact, the process of accommodation and tuning of the meaning of words and linguistic expressions continues for each of us throughout our lives and no matter how long

we have spoken the language, there will still be occasions when we realize that we have been using a word in a way that turns out to be idosyncratic in some particular respect.

Once we have come to see this essential and inescapable subjectivity of linguistic meaning, we can no longer maintain the preconceived notion that words *convey* ideas or knowledge and that the listener who apparently "understands" what we say must necessarily have conceptual structures that are identical with ours. Instead, we come to realize that "understanding" is alway a matter of fit rather than match. Put in the simplest way, to understand what someone has said or written means no less but also no more than to have built up a conceptual structure that, in the given context, appears to be ***compatible*** with the structure the speaker had in mind--and this compatibility, as a rule, manifests itself in no other way than that the receiver says and does nothing that contravenes the speaker's expectations.

From this perspective, there is an inherent and inescapable indeterminacy in linguistic communication. Among proficient speakers of a language, the individual idiosyncracies of conceptual construction rarely surface when the topics of communication are everyday objects and events. When a conversation turns to predominantly abstract matters, however, it usually does not take long before conceptual discrepancies become noticeable and generate perturbations in the interaction. At that point the difficulties often become insurmountable if the participants believe that *their* meaning of the words they have used are fixed entities in an objective world outside the speakers. If, however, the participants take something like the constructivist view and begin by assuming that a speaker's meanings cannot be anything but subjective constructs, a productive accommodation and adaptation can mostly be reached.

For this reason, I believe that the constructivist orientation can be of great benefit to the teacher. Being aware of the inherent subjectivity in the interpretation of pieces of language, the teacher will be aware also of the fact

that, no matter how instructions are formulated, they are always subject to more than one ***reasonable*** interpretation. In other words, when a student reacts in a way that is not at all the way the teacher desired or expected, this does by no means always indicate that the student has committed a logical error. On the contrary, the reaction may make very good sense to the student, simply because the concepts in terms of which the student ***sees*** the situation are in one or more respects discrepant from those that seem "obvious" to the teacher. In that case it is of little avail to tell the student that he or she is ***wrong***. Instead, it will in most instances be far more productive for the teacher to try to infer a model of the student's conceptual structures, no matter how outlandish they may seem, because it is only when the teacher has some inkling "where the student is" that ways can be found to lead the student to make an accommodation that could produce more desirable results.

Conclusion

The constructivist analysis of the two concepts discussed here goes against the traditional ideas of realists, be they naive or sophisticated, materialist or metaphysical. It treats both our knowledge of the environment and of the items our linguistic expressions refer to as subjective constructs of the cognizing agent. This is frequently but quite erroneously interpreted as a denial of an experiencer-independent, *ontological* reality. But even the most radical form of constructivism does not deny that kind of independent reality--it merely asserts that it is not accesible to rational knowledge because it manifests itself only through the constraints that make some of our ways of acting and thinking unsuccessful; and, from the subject's perspective, any such constraint is experienced (and therefore knowable) only as the break-down of an action or thought.

The tentative suggestions constructivism might make to educational researchers and educators will not contain much that would be new to teachers who have been consistently

successful in the past. The novelty resides in the fact that the constructivist orientation provides a theoretical foundation to practices that hitherto were the outcome of intuition rather than of a deliberate, explicit program--and this new theoretical foundation is largely incompatible with the traditional dogma of the educational establishment.

At the basis of the constructivist theory of knowing is first of all the idea that knowledge is not an iconic representation of an external environment or world, but rather a mapping of ways of acting and thinking that are ***viable*** in that they have proven helpful to the acting subject in attaining experiential goals. Second is the idea that this kind of knowledge is under all circumstances the result of an individual subject's constructive activity, not a commodity that somehow resides outside the knower and can be ***conveyed*** or ***instilled*** by diligent perception or linguistic communication. Third is the idea that language is not a means of transporting conceptual structures from teacher to student, but rather a means of interacting that allows the teacher here and there to constrain and thus to guide the cognitive construction of the student. This guidance, as good teachers have known all along, necessarily remains tentative and cannot even approach absolute determination. From the constructivist point of view, this must be so, not only because there is always more than one solution to a problem, but also because the problem situations themselves, given that they do not exist independently in an objective environment, are seen, articulated, and approached differently by different cognizing subjects.

The most obvious corollary of this theoretical position is that the solution of a problem will give satisfaction (and thus increase motivation) only if it leads to the attainment of a goal that was chosen as goal by the acting subject. From this it follows that an individual's incentive to ***do*** mathematics and to get deeper into the abstract operations mathematics consist of, can grow only in an acting subject who has discovered the incomparable satisfaction one

attains when one solves a problem one has chosen oneself according to rules and criteria one has appropriated as one's own.

Footnotes

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